

NATURAL GAS IN THE XXI CENTURY

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Abstract

Ever growing importance of natural gas in the world energy balance is a formed stable tendency the action of which is strengthened by energy factors and ecological and economic factors.

The world gas industry develops rapidly. In the year 2000 2.347 bln m³ of gas were produced, and the proved reserves of natural gas amounted to 150.0 trln m³ as of January 1, 2001. One fourth of consumed primary energy resources is natural gas. The greatest level of consumption has been reached in North America (31%), then the CIS countries (27%) and countries of Europe (20%).

In the XXI century the volumes of international trade of gas will increase, new gas transportation trunk pipelines will be developed and gas will greatly contribute into globalization of the world economy.

The share of Russia is more than one third of proved gas reserves, one fourth of its world production and half of all supplies to the world market of gas.

Introduction

At present natural gas holds a special place in the world energy structure – it belongs to a group of most widely used energy carriers (along with oil and solid fuel significantly outstripping the atomic energy and renewable sources of energy including hydropower) and it belongs to the most perspective resources of energy simultaneously.

In many cases all main vectors of criteria for choosing energy resources – maximum energetic, economic and ecological efficiency – point to natural gas.

Gas industry acquires a really world scale putting away the differences in geography and thus multiplying advantages of gas.

Speaking about the future of gas it is impossible to miss such an important moment as environmental protection. Being one of the most ecologically pure out of all widely spread now kinds of fuels gas is bound to be one of the central elements of our mutual struggle against harmful emissions into atmosphere, the latter resulting in sadly known “greenhouse effect”.

Natural Gas in the World Energy

Predicting of perspective energy development, determining of rational energy supply scales, preparing of structural, organizational and technical resolutions done in good time must adequately respond to the problems facing society at that period of time.

For the forthcoming 20–30 years the following problems can be mentioned:

- demographic growth in developing countries, the specific weight of which in population of the globe will exceed 90%;

- global deterioration of environmental conditions (greenhouse effect, ozone holes, radioactive wastes);
- aggravation of the resource problem; increase of energy usage efficiency and appearance of new energy resources.

So, the task of creating energy with stable development must take into consideration all these different tendencies and must meet the requirements of energetic, economic and ecological efficiency.

For the last two centuries mankind has made its progress by way of changing technological modes of life, with own dominating energy resource being attributed to each of them. Last century this resource was coal, then oil. New, so-called post-industrial, technological mode of life being in progress at present time is based on ever growing role of natural gas in sources of primary energy and electric power in the final energy consumption.

During the last 25 years the world energy consumption increased by 38%, consumption of natural gas being increased by 65%, oil – by 12%, coal – by 28%. During this time share of natural gas in the balance of primary energy resources increased from 19% to 23,7%, share of oil decreased from 49% to 40,1%, and coal – from 30% to 26,2%.

It is due to its speed of spreading that gas can be considered to hold the leading place during the first decades of the XXI century.

As a rule, factors restricting the scales of natural gas usage are: rather rigid and highly capital-intensive infrastructure of natural gas delivery needs a definite level of proved volumes of effective demand to be available in order to realize new projects; and in case of pipeline transportation – it also needs problems of transit to be solved as well as political and economic stability in zones discussed in a project to be available for a long time of its recoupment. Factors of importance are those under which there is a danger for economies of the corresponding countries and regions to be dependent on only one or very few number of energy resources, and rigid infrastructure and capital intensity of gas industry often cause such situation. Natural restricters for “zone of influence” of these or other sources of natural gas supply also have their effect depending on expected levels of price for gas at the corresponding markets. The corresponding numerical estimations and conclusions can be influenced by changes in macroeconomic situation and by application of new technologies.

Estimating gas from point of view of its demand and supply the major attention should be paid to its competitiveness in regard to other energy carriers.

A number of factors act in favour of natural gas:

- general tendency to growth of energy consumption dealing with world energy development;
- appearance of ever more advanced technologies for using gas in various industries and sectors of economy;
- ever growing importance of ecological purity of gas in comparison with other kinds of fossil fuel.

Advantages of gas in view of environmental protection cause no doubts. As ecologically pure fuel it gives low level of harmful emissions, of sulphur dioxide in particular, and as carbon fossil fuel it gives low level of carbon dioxide, lower than coal and oil. So, substitution of other kinds of fuel with gas can quickly and effectively improve situation dealing with "greenhouse effect".

At present different organizations are working out a long-term forecast for world energy development up to the year 2050. It is obvious that in such forecasts the depicting of definite tendencies in light of the present day situation is of much more importance than just detailed numerical evaluations, the latter depending on too many factors of uncertainty. According to the forecasts being developed a considerable scattering of possible levels of gas production is observed in the middle of the forthcoming century – from 5 to 8 bln. tons of standard fuel. It is important that even minimal level implies further development of gas industry. Meanwhile moderate "pragmatic" variants suppose that share of natural gas in balance be increased up to 28%–30%.

Resources of Natural Gas

Up-to-date proved reserves of natural gas of the whole world comprise 15 trln. m^3 and considering current and expected levels of production this fact provides better conditions for reserves of natural gas compared with oil. International Gas Union (IGU) estimates the resources of natural gas approximately up to 400 trln. m^3 though it is clear that their transfer into the category of proved ones will require a great scope of exploration work. Moreover, it is important to note that international classification of reserves takes into consideration economic efficiency of their being recovered under conditions of current price level. This factor can vary with changing prices, in particular in case of their falling down as situation is at present time. The geological natural gas reserves of Russia comprise 236,1 and proved reserves – 46,9 trln. m^3

Besides conventional gas resources the proved reserves of which are sufficient for 60-year and, taking into account new discoveries, for 90–100 year period of time there are so-called non-conventional natural gas reserves the completion of which will secure an assured development of gas industry beyond the limits of XXI century.

They are:

- tight gas;
- coalbed methane;
- gas dissolved in formation waters;
- gas hydrate;
- deep gas.

Unconventional gas reserves are some tens and may be even hundred thousand trln m^3 .

Gas Industry of Russia in the XXI century

The largest gas industry in the world was developed in Russia in the second half of the XX century (Fig. 1). Unified gas transportation system embraces the dominant part of the North-Western area of the Euroasian continent.

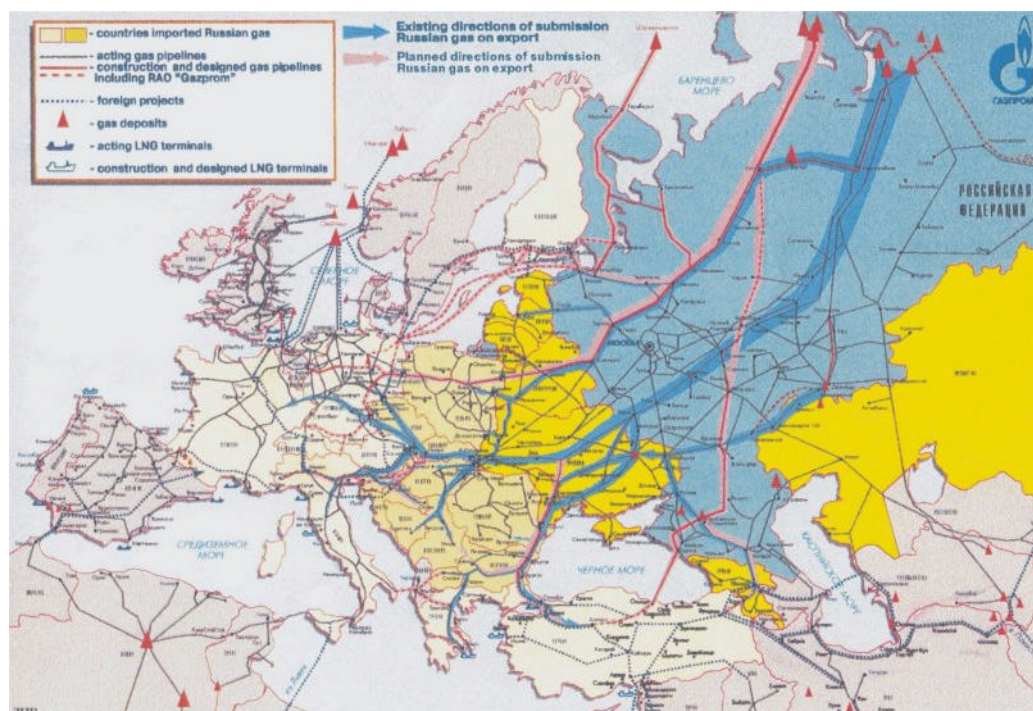


Figure 1 – Delivery directions of Russian natural gas to Europe

In comparison with the corresponding total world factors one third of all explored reserves of natural gas and one forth of its production are concentrated here (Fig.2).

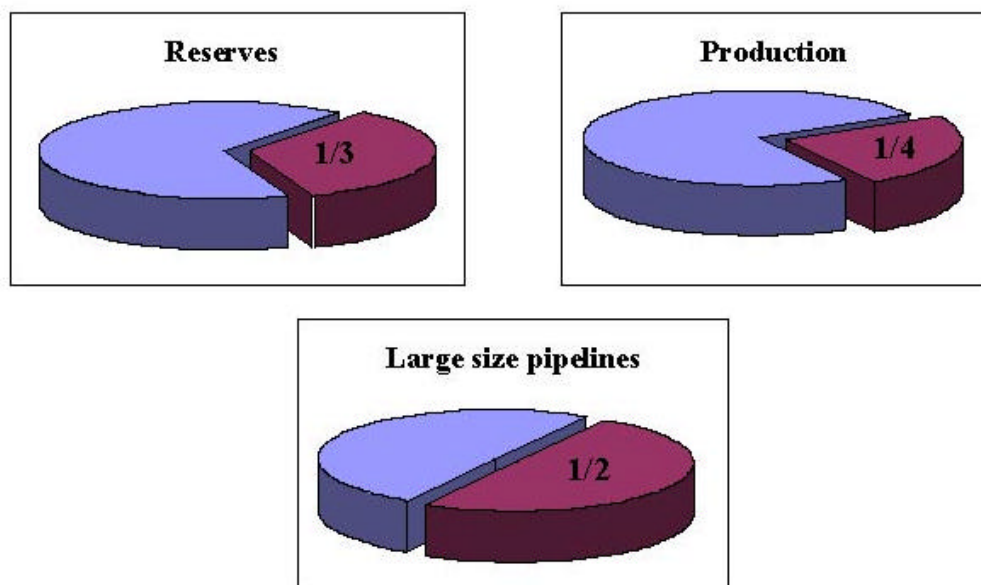


Figure 2 – Role of Russia in World gas industry

Russia possesses enormous resources of gas many times exceeding cumulative production (Fig.3).

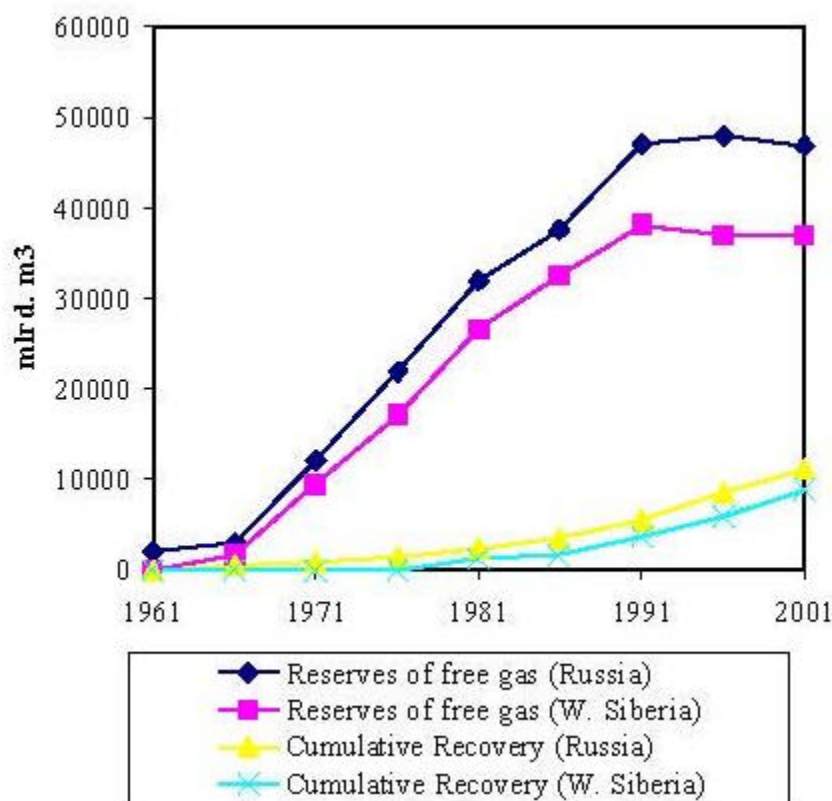


Figure 3 – Proved reserves and cumulative recovery of gas in Russia

It is remarkable that during the last ten years in spite of economic crisis the ratio of gas reserves and gas production has not been reduced both in the Russian Federation and in the Western Siberia but, moreover, it has increased to some extent.

In accordance with the Energy strategy of Russia in 2010 production of gas will comprise 650,0 bln.m³, 700 bln.m³ in 2020 and 750,0 bln.m³. in 2030. Meanwhile it is planned by GAG "Gazprom" to produce 530,0 bln.m³ before the year 2030). Consequently, the share of independent producers and oil companies is 120,0 bln. m³ of gas production in the year 2010, 170,0 bln.m³ in the year 2020 and 220,0 bln.m³ in 2030.

To maintain the planned levels of gas production in the Nadym–Pur–Tazovsky region in .the year 2002 gas field Zapolyamoye was brought into service. Before the year 2005 fields Pestsovoye, Kharvutinskoye, Anariyakhinskoye and others will be brought into operation.

In 2006 it is stipulated to complete Bovanenkovskoye and Kharasaveiskoye fields on the Yamal Peninsula with volume of production up to 180 bln.m³. Later on it is planned to get ready new fields of the Yamal Peninsula that will enable to bring gas production up to 240,0 bln.m³.

The largest fields on the shelves of the Barents Sea, the Okhotsk Sea and the Kara Sea have been discovered including the Shtockman gas field. More than 2,7 trln.m³ of gas reserves have been explored in the Eastern Siberia and in the Far East, out of which only 7,4% are being developed.

Out of the unexplored onshore resources about 43% are accounted for the Eastern Siberia and the Far East, 47% – the northern regions of the Western Siberia.

Kovyktinskoye field in the Irkutsk province and Chayandinskoye field in the Republic of Sakha (Yakutia) will be another big centre of gas production in the second half of the period considered.

On the whole in industry gas production at the operating fields will be about 142 bln.m³ by the year 2020. New fields will account for more than 76% of gas production. Program for completion of fields and deposits that are of small size and of low production rates, especially in well developed, from economic point of view, European regions will have regional significance.

From history gas industry of Russia dealt only with one market of gas that is the European market. Now Russian gas is supplied to 19 countries of Europe (not taking into account the CIS countries) thus meeting 26% of their demand in gas (Fig.4). According to contracts concluded (their terms being ex

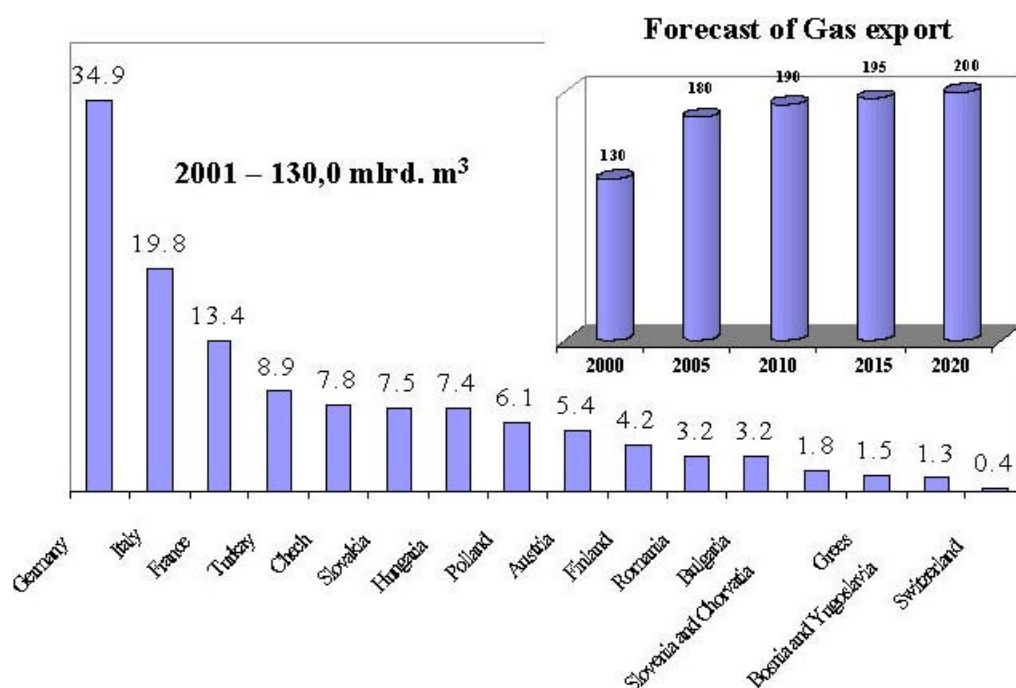


Figure 4 – Export of Russian gas to European countries, mldr.cubic m.

pired in 2010–2015 and later on) in case of favourable economic situation for market of gas the supplies of Russian gas will increase to some extent. Russia strictly fulfils all its obligations, the reliability of our supplies is proved by international audit of gas reserves, by audit of financial accounting and by conclusions made by specialists from the European Bank of Reconstruction and Development about technical state of gas transportation systems.

Aspiration of the European countries toward the diversification of supplies and liberalization of gas markets being conducted now demands that we should pursue a flexible policy of export.

In particular, step-by-step development of gas transportation system Yamal–Europe is stipulated (Fig.1) with a possibility of overstripping setting into operation the North-European gas pipeline.

The latter will increase the reliability and efficiency of gas supply, will improve conditions for its realization in Germany and will enable to enter the market of Belgium and further on through 'Inter-connector' of Great Britain.

To make gas supplies for export more reliable it is planned to diversify the routes of gas supply (Fig.5).

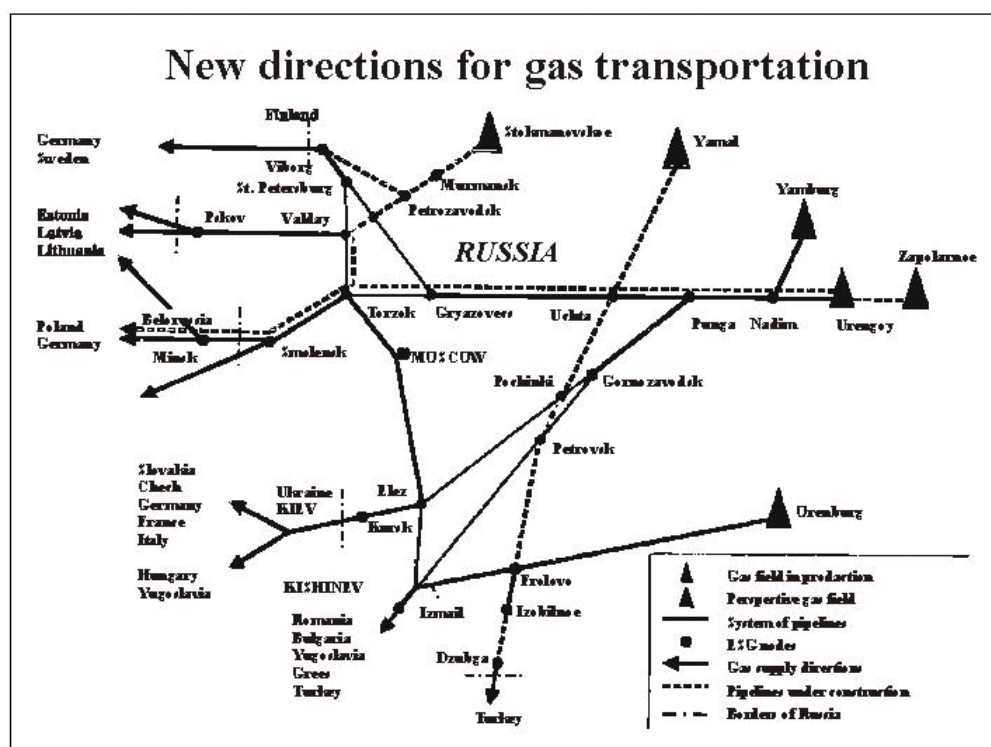


Figure 5 – New directions for gas transportation

- In addition to operating gas transportation systems through which gas is transported to Europe through the territory of Ukraine and Moldavia it is planned to supply gas in new directions:
- the central part of the European territory of Russia–Europe, the route is laid through the shortest way through Belorussia and Poland;
- the central part of the European territory of Russia–Turkey, the route is laid only on the territory of Russia and through water area of the Black Sea;
- Shtokmanovskoye field–Murmansk–Vyborg–water area of the Baltic Sea with outlet to North-Western. Europe.

Directions mentioned above will allow to decrease the number of countries-transitors, to use on a wide scale international waters and to reduce the distance of gas transportation.

- In 2000–2015 it is planned to create new gas transportation directions (Fig. 6);

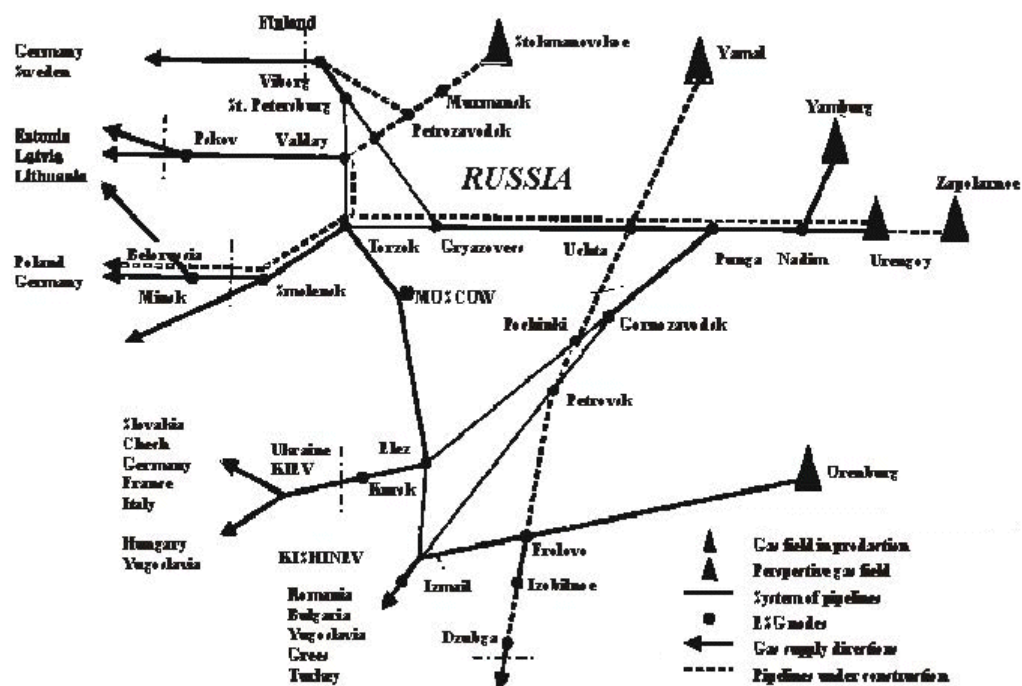


Figure 6 – Diversification of export gas supply

- Yamal–Ukhta–Torzhok–Smolensk, with outlet to Poland and Germany through Belorussia;
- Shtokmanovskoye field–Murmansk–Petrozavodsk–Saint Petersburg–Vyborg, with outlet to Finland and Sweden;
- Yamal–Ukhta–Pochinki–Petrovsk–Frolovo–Izobylnoye–Dzhubga, with outlet to Turkey through the Black Sea.

To ensure gas supplies for export during 15-year period it is necessary to construct more than 12 thousand km of pipelines and to construct about 70 compressor stations.

The total cost of constructing these pipelines will comprise about 42 bln. doll. (USA) taking into consideration the Arctic and offshore projects.

Diversification of Russian export stipulates active completion (along with conventional European completion) of the Southern direction as well.

In this respect the project “Blue Stream” for supplying Russian gas to the market of Turkey is of special priority (Fig.1). Demand for gas in Turkey in the year 2020 is estimated to be 80 bln. m³ and various projects can find their places at this quickly developing market. The realisation of the project “Blue Stream” is in full swing, construction consortium has been established (with offshore area, so to say “ready for key”, being brought into operation), sources of financing have been determined, privileges on taxation in Russia. To increase gas supplies to Turkey an operating system of gas pipelines at the Balkan Peninsula will be extended in the nearest years.

With restoration of economy and with effective demand the gas markets of the GIS countries will become attractive for Russia and export of gas can be increased by 25–30% before the year 2020.

At the same time mutually profitable import of gas to Russia from the CIS countries, first of all from Turkmenistan and Kazakhstan, will be enlarged.

The Far East region – China, Korea and Japan – will be in principal important for us as a perspective market for the pipeline system gas. Different variants of Russia's taking part in developing this market are being considered. At the first stage of construction of the Far Eastern gas transportation system it is planned to construct a gas pipeline from the fields of the Irkutsk province and those of the Republic of Sakha (Yakutia), with supplies reaching up to 30 bln.m³ of gas per year (Fig.7).

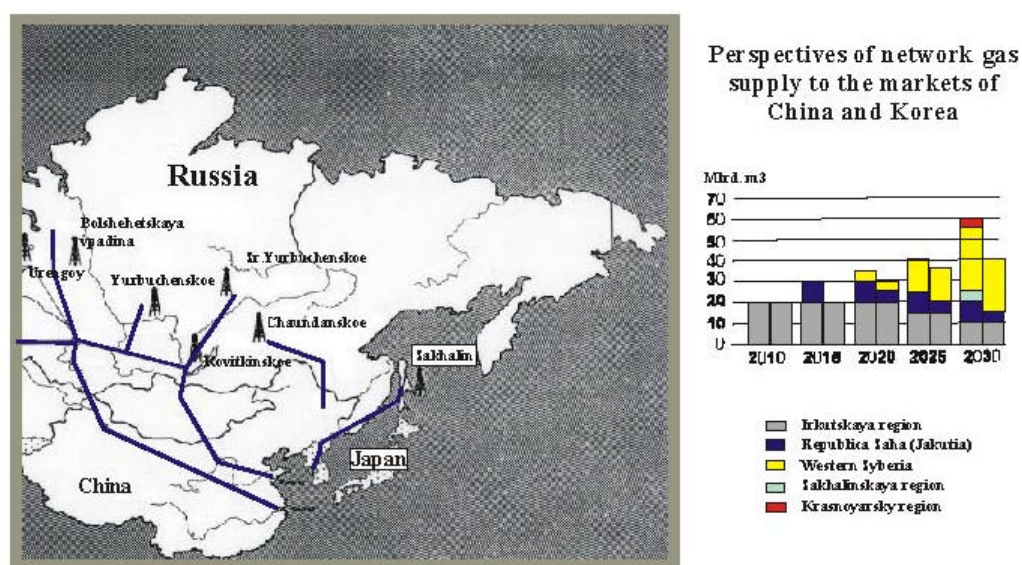


Figure 7 – Gas transportation network in the East of Russia

Gas of the Sakhalin shelf (Sakhalin-2) will be mainly directed to the market of liquid gas. Construction of gas transportation system to China and Korea through Khabarovsk is considered as one of possible variants. Annual volumes of the Sakhalin gas supplies can reach 12–15 bln.m³ by the year 2010 and 20–25 bln.m³ by the 2020. To deliver gas to consumers and to secure transit it will be necessary to develop gas transportation systems in the Eastern Siberia and in the Far East very substantially.

Gas industry of Russia preserves the leading place in the world gas production and gas export. According to forecasts made by the World Energy Council the share of Russia in the world gas production will comprise 2% in the year 2020 and in terms of volumes of international gas trading it will be 30–35% (Fig.8).

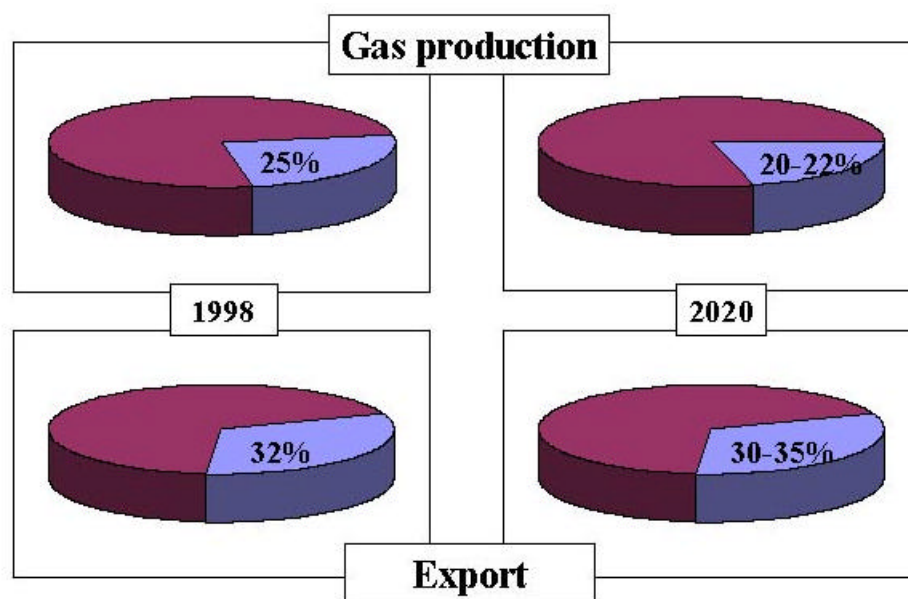


Figure 8 – Forecast of Russian share in World gas industry

Special role of Russia in establishing the unified Euroasian gas market is predetermined by its geographical position. On the basis of transcontinental gas transportation system the construction of which is forecast to take place in the first quarter of the XXI century there will be given a start to formation of the unified Euroasian energy space.

New Perspective Technologies of Gas Industry

Progress made in the world gas industry development is determined to a considerable extent by new effective energy- and resource-saving ecologically pure technologies.

Fast growth of gas usage has become a catalyst for new technologies without which gas usage would be provided neither from economic point of view nor from technical point of view.

The problem of generating electric power with natural gas being used is of a special significance. This sector of energy has not received practically any noticeable development in the world except Russia. However, it is here that changes come into being and fast growth, is expected in this sector. According to some analysts' opinion this field of gas application will be developed especially actively in the countries of the European Union, in the USA, and during the nearest 20 years electric power production using micro turbines will increase up to 20%.

Undoubtedly, gas positions have become stronger after gas usage being started in turbine generators of combined cycle efficiency of which achieves 90% and even higher.

Modern generations of gas turbines for producing electric power are certainly more economical than those technologies that have already become out-of-date since they were based on using coal. Efficiency of heat electric generating plants of combined cycle achieves 60% and it is the highest level in power industry.

It is certain that during the last 25 years perfect technical indexes were provided by fuel elements with gas being used. The fact of special importance is that they are characterized by low level of

emission of emission nitrogen oxides and other harmful substances. Owing to these properties gas fuel elements have already become and will remain in future a preferable technology in power industry. Moreover, general tendency in energy supply is well known: power stations of minimal capacity but they are situated at maximum closer to the final consumers and they are maximum economical at the expense of saving means on transportation of energy.

In residential sector gas has won new positions thanks to condensation heaters. For future gas can be used in washing machines, dish washing aggregates, rubbish gathering machines and refrigerating plants.

In automobile transport gas can be used for solving a problem of developing ecologically pure kinds of fuels. Even today compressed gas and liquefied natural gas as an engine oil are used by many countries. In 1989 at the International Gas Conference Russia demonstrated an aircraft that arrived in France using natural gas.

At present time in the USA more than 60 thousand automobiles operating on natural gas are in service; world-park of such automobiles comprises about 1 mln. Automobiles operating on gas emit into atmosphere carbon dioxide by 20% less than those operating on gasoline. It is extremely important taking into account the fact that transport industry is responsible for one third of greenhouse gases emitted into atmosphere as a result of human activity.

In perspective the gas market for transport can be extended by automobiles with hybrid engines using technology of fuel elements which also are more preferable from environmental point of view.

Development of new technologies during the first decades of the XXI century will greatly contribute to a more effective gas usage as raw material for chemical industry.

By present time economic vitality has been proved by two ways of gas transportation: by pipelines and in the form of LNG.

The beginning of an active gas usage falls on the 70ties. Since then LNG producing companies have been concerned with only one thing: how to reduce its production costs. The solution of the problem lies in new technologies and thoughtful marketing policy. One can hope that it will be possible already in the nearest future to increase profitability of MB production by 25%.

If it is really so LNG will be able to compete with gas being transported by pipeline. It is a well-known fact that the cost of constructing onshore gas pipelines at large distances has not been reduced considerably for the last decade.

The "gas-into-liquid" technology has big perspectives, it is based on transforming natural gas into liquid which by its properties is very close to oil. It is much more easier to transport this liquid by pipelines or with help of tankers. The process like this can be performed both at offshore platforms and barges that will make gas production from wells not connected to pipeline system easier.

From commercial point of view gas being used as fuel for electric power generation ("gas-along-wires") becomes an alternative to gas transported by pipeline.

It is obvious that the most promising technology is development of transcontinental pipelines enabling to transport simultaneously Liquid gas and electric power. Technology is based on the effect of superconductivity and will allow to solve a problem of gas and power transportation for long distances from gas fields and power stations of Siberia to Europe and countries of the Asian and the Pacific Oceanic region.

Globalization of Gas Market

During the 1994–1997 year period the Committee “Strategy, Economics and World Gas Reserves” of the International Gas Union (IGU) carried out a study on long-term development of natural gas consumption and its resources. Representatives of 42 IGU member-countries took part in this work under Mr. Georges Bouchard's supervision.

During time period from 1970 till 1995 volume of international gas trade increased by 10 times and achieved 489.0 bln m³, out of which 92.0 bln m³ were sold in the form of liquefied gas using tanker fleet. A conclusion has been made that volumes of inter-regional trade will be doubled by the year 2010 and they will be by the year 2030.

International trade at present are divided into three main markets of gas trade:

- Europe is the biggest importer of gas having 60% of total volume of gas sold in the world (including intra-regional trade). The leading exporters – Russia, Algeria and Norway;
- The North America is the second region of gas trading, big amounts of gas are transported from the Western Canada to the major consumption markets in the United States;
- Asia is the main region of import trade of liquefied gas. Japan, South Korea and Taiwan increase import of liquid gas to support their growing needs in natural gas for power production and also for using it in domestic (residential) sector and in industry.

The International Gas Union in its study has made a conclusion about that volumes of gas trade have increased sharply, new gas transportation trunk pipelines have been developed and high rates of gas market globalization take place.

Growth of demand for gas at the main regional markets of consumption along with insufficient geological reserves and deficit of gas supplied can result in impressive growth of inter-regional trade of gas by the year 2030. Analysis of scenario and demands for gas shows that dramatic changes should take place in the picture of inter-regional trade of the year 2030. One can make the following conclusions:

- inter-regional trade of gas is expected to develop continuously in the same way as it developed during the last 25 years. It can grow up to 320.0–400.0 bln m³ in the year 2010, 500.0–600.0 bln m³ in the year 2020 and up to 650.0–800.0 bln m³ in the year 2030;
- up to now inter-regional trade limits itself with three main flows, development of new projects will entail internationalization of gas trading routes and globalization of gas industry;
- two regions will play the leading part in the development of inter-regional trade: the Western and the Central Europe that is able to import more than 500.0 bln m³ in the year 2030, and the Central Asian region that is able to import about 300.0 bln m³ in the year 2030.

- It is most difficult to make predictions about inter-regional trade in the North America. Depending on economic encirclement, on price changes the region can become either importer or exporter of gas;
- Surplus of gas reserves in five regions-exporters of gas (Russia, the Middle East, Africa, South-Eastern Asia and Oceania, South America) will exceed deficit of reserves in to three regions – importers of gas (Central and Western Europe, Southern and Eastern Asia and, perhaps, North America) demonstrating the fact that geological reserves o gas are sufficient to cover the growth of needs. However, surplus of gas is mainly concentrated in Russia and in the Middle East. It means that these two regions will be responsible for redistributing reserves and demands for gas all over the world;
- Necessity to rely on far-distant sources will lead to development of trade with liquefied gas. It will allow to change main conventional markets (Europe and Far East), liquids gas will result in the appearing of new isolated markets, diversification of gas reserves and further growth of the main gas markets at which pipeline trade achieves its technical, economic and political limits. In the period of time before the year 2030 world trade of liquefied gas can grow considerable. Such development will strengthen globalization of gas industry that will be accompanied by enlarging trade routes and by the appearing of new countries-exporters/importers of gas.

In future development of gas trade depends on construction of a large number of pipelines and new schemes (systems) dealing with liquefying gas. At present all over the world not less that 20 projects an gas liquefaction are being realized as well as 85 projects are being realized for laying new international pipelines or for reconstructing those already being in existence. It shows dynamics of future trade of gas and that of gas industry and it also underlines the role which natural gas plays in solving the problems of globalization of the world economy.

Conclusion

Looking at the distant perspective for energy development and trying to determine the role of natural gas in it attention should be paid to the following peculiarities of the world picture:

- being modern conventional energy consumption centers industrialized countries will remain as big consumers with stable and slowly falling levels of energy usage that will be first of all accounted for the results of energy-saving policy and changing structure of their economies;
- new sources and centers of fast growing energy usage will appear. First of all these are countries of the South-Eastern Asia and of the Oceania being actively involved into the process of industrialization and postindustrialization development, and Latin America also following this way;
- China and India will add already in the nearest decade the number of countries being big energy consumers;
- the existing disintegration of energy production and energy consumption will be preserved, but will be perhaps slightly smoothed due to a wide completion of the shelf energy resources, internationalization of companies, progress in the field of nuclear energy and due to the role of oil falling down;

- taking into consideration its resource base and favourable ecological properties the role of gas in the world energy supply is potentially very great. But realization of this potential will take place in a competitive struggle with other kinds of fuel and energy: in the nearest years – first of all with oil and coal, and in the far perspective – with coal and atomic energy produced on the basis of safe nuclear reactors and then with renewable energy resources and nuclear energy.

Development of new in principal and economical enough technologies for production of conventional and non-conventional gas resources as well as new energy- and resource-saving, ecologically pure technologies for transportation, processing and usage of gas will secure an assured development of the world gas industry in the XXI century.